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We look at the latest forecasts for the mobile-phone market, as well as shifts in technology and the impact these are having on the strategies of component manufacturers.

Trends in mobile telecoms

After sales of mobile phones increased rapidly early last year, the forecasts for 2000 spiralled from initial forecasts of just over 400m towards 450m. But in second-half 2000 sales slowed, due to increasing saturation in rapidly maturing markets (particularly in Western Europe, where penetration levels are high, subsidies are reduced, and non-active subscriptions are being pruned). Consequently, sales in 2000 - though still over 40% up on 1999's 284m - were "only" about 412m.

Likewise, in April **Dataquest** cut its 2001 forecast from 576m (40% growth) to 506.5m (23% growth - see Issue 5, page 4) then again at the end of May (after sales of just 96.7m in Q1/2001) to "perhaps 500m".

In contrast, the **ARC Group** (which had origianlly forecast 410m for 2000) in June's report "*Future Mobile Handsets - Worldwide Technology and Market Developments 2001-2006*" forecast 491m (up 21% on 2000), reckoning on a boost in Q3 and Q4/2001.

After lowering its October 2000 forecast for 2001 sales of 550m to 500-550m (see Issue 1, page 4) in March **Nokia** cut this again to 450-500m (Issue 3, page 4). Though reckoning that sales in second-half 2001 will be significantly larger than in first-half 2001, in June it said that 2001's total will now only be flat or modestly above last year's 405m. Likewise, early this year Siemens cut its forecast from 500m to "below 450m".

After **Motorola** had initially forecast 525-575m, it lowered this in February to "sub-500m" (see Issue 2, page 4), then again in the spring 425-475m then in July to 400-425m. But sell-through (i.e. phones sold through distribution channels, including left-over inventories) will be 425-450m, it says (5-10% up on 2000), with inventories whittled down to normal levels.

In fact, inventory build-up in the distribution channels has caused some confusion regarding market forecasts. According to **Dataquest**, an inventory overhang of 30-35m OEM shipments may have remained unsold as channel stock at the end of 2000, plus another 5-10m of OEM factory inventory carried over into 2001. Therefore *oversupply in 2000 resulted in OEMs selling more handsets to end-users in Q1/2001 than shipped into distribution channels.*

Ericsson's new estimate for sell-through (units purchased by end-users) is 400-440m, and for sell-in (shipments to distributors) is 370-410m. (Its previous estimate in Q1/2001 of 430-480m was for sell-through, it emphasizes.)
WIT SoundView has lowered its estimates for handset sell-in from 455m to 388m.

Akira Minamikawa, senior analyst at **WestLB Securities Pacific Ltd**'s Tokyo office, reckons that last year there were orders [from distributors] for about 470m but only about 400m shipped [to customers]. Production will balance demand in second-half 2001, but inventories will not burn off until Christmas. "*This year I see demand for 430m phones but component orders for only 360m*," he adds. However, there will be a rebound next year.

Ericsson reckons that, since difficult market conditions will persist for the rest of this year, many operators are reducing their capital expenditures by running existing networks at higher utilization levels and deferring network expansion (as with the fibre-optic networking sector).
The Strategis Group adds that "Since the capital markets have dried up, telecom organizations have shifted focus from expanding and deploying new networks to retaining and attracting customers by differentiating themselves from competitors".

Operators are curbing spending as they wrestle with debt from a combined US$100bn to buy 3G spectrum in government auctions, as well as also cutting back due to concern that the technology underpinning these new services has been slow to materialize. As a consequence, as the debut of integrated 3G IC solutions is delayed, the "life-cycle" of GSM, CDMA, TDMA, AMPS and particularly 2.5G GPRS systems will be extended.

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GPRS-led pick-up in Q3-Q4?

Motorola says there are already signs of recovery in the market. It expects increased demand - especially for new 2.5G products - in Q3/2001. As well as Motorola, both Ericsson and Siemens already have 2.5G GPRS phones on the market.

However, with an expected 36% market share in 2001, much hinges on Nokia's September launch of its GPRS handsets for the Christmas season. Otherwise, a shortage could mean that operators cannot launch full-scale GPRS services until 2002.

Meanwhile, the present economic stall is prompting OEMs and IC suppliers to preserve the essentials while pursuing higher levels of semiconductor integration. The move toward complete solutions (as multimedia functionality is emphasized over conventional communications) means that consolidation and convergence will be pervasive in all stages of handset design.

RF devolving to chip makers, prompting alliances

According to **Allied Business Intelligence**, wireless chip-set vendors face a rapidly evolving market that will lead to consolidation.

Technology alone is not the market differentiator. In first-generation handsets, RF expertise was mostly in the hands of the phone suppliers, says Andy Fuertes, vp of communications technologies. But now handset makers are focusing on their true value in the supply chain, which has become distribution, branding and aesthetics. The manufacturing and development of the RF technology is correspondingly being passed down to the component suppliers.

In addition, consumer electronics companies such as Siemens and Sony have been entering the handset market, together with other entrants from networking. Therefore 3G technology (which includes wireless Internet access) "is seen almost as a computing platform," says Fuertes, with software and interfaces becoming differentiators.

Handset makers will look more to chip suppliers for complete solutions. These can already be offered by the likes of Conexant Systems Inc and Infineon Technologies, but more specialized RF companies such as RF Micro Devices, TriQuint, Anadigics and Alpha Industries are being driven into partnerships or mergers to survive.

"Low margins among leading manufacturers and demand for complete solutions among all handset suppliers have made this the opportune time for mergers and acquisitions among handset IC vendors," Fuertes adds.

Modules integrating switches and filters

Earlier this year **TriQuint Semiconductor Inc** (Hillsboro, OR, USA) said it would not pursue MCM-level integration until it saw evidence for demand, focusing rather on increasing RFIC functionality for 3G roll-out for tier-one customers such as Motorola, Ericsson and Nokia (see Issue 2, page 6). However, in July TriQuint acquired Surface Acoustic Wave device manufacturer **Sawtek Inc** (Orlando, FL, USA), enabling integration of Sawtek's SAW filter/switch into TriQuint's RF modules.

TriQuint says that, as wireless OEMs seek to streamline their operations and reduce their supplier base, it has become increasingly important for RF component vendors to offer a broad range of leading-edge products. The merger will provide handset makers with an integrated, module solution that combines several chip-set functions.

While the digital portions of handsets are now highly integrated, the RF sections are still dominated by large numbers of discrete or partially integrated components. Sawtek president and CEO Kimon Anemogiannis states, "While RFICs and SAW filters must work together to maximize radio performance, there has been very little effort in the past in this direction."

Highly integrated RF modules should offer significant cost, size and logistics benefits. "This will enable us to sell complete RF front-end modules," says TriQuint's president and CEO Steven J Sharp. "For the first time in the history of mobile phones, there will be a convergence of technologies to produce an entire radio on a single, low-cost module," he adds. TriQuint will be integrating [module] products this year and will be in production early next year.

As part of a roadmap based on its Alpha Integration Platform (aiIP), **Alpha Industries Inc** (Woburn, MA, USA) has formed a strategic alliance with Surface Acoustic Wave filter supplier **EPCOS AG** (Munich, Germany). They will co-develop, manufacture and market a new family of switch/filter modules (including control logic circuitry, switching and transmit/receive filtering), initially for dual-band (to be shipped in September) and eventually tri-band GSM handsets.

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EPCOS is Europe's largest manufacturer of passive components, with expertise in Low Temperature Co-fired Ceramics (LTCC), which has become a major integration medium for passive and active RF components.

Transition from RFICs to modules reviving sales, but only after high start-up costs

Due to both (i) the slowdown in manufacturing (leading to investment in more sophisticated, next-generation chip technology in anticipation of the introduction of the 2.5G and 3G standards stimulating the market) and (ii) the need for cheaper, more compact, integrated components with higher functionality, a major shift has been underway from stand-alone RFICs to modules which integrate RF chips such as power amplifiers with passive components and other functions such as filters.

"The handset industry is in the midst of a transition", says **RF Micro Devices Inc** (Greensboro, NC, USA). "Mature, high-volume handsets incorporating IC power amplifiers are nearing the end of their product lifecycles and being replaced by new models incorporating more complex, highly integrated Multi-Chip Module power amplifiers". RFMD has thus embarked on a technology shift from stand-alone ICs to multi-chip modules containing one or more ICs plus passive components.

RFMD's power amplifier product line director Joe Grzyb says "Handset manufacturers, particularly those in Asia, have shown growing interest in technology platforms, due to the need for accelerated time-to-market, reduced cost, ease of assembly and overall desire to reduce reliance on design engineering resources, which remain in short supply in the industry." He adds, "We believe this trend [to technology platforms] has accelerated recently as tier-one manufacturers have outsourced to these Asian handset manufacturers."

"We're seeing essentially all major handset manufacturers transitioning to modules in their next-generation handsets".

David Norbury, president and CEO, RF Micro Devices

RFMD's investment in module technology is "as strategic to future growth as the decision to adopt GaAs HBT several years ago", says president and CEO David Norbury. "We're seeing essentially all major handset manufacturers transitioning to modules in their next-generation handsets".

RFMD (which supplies RFICs mainly to Nokia) saw June-quarter sales of US$70.1m - still down 28.7% on a year ago but up 27.3% on the March-quarter's US$55m (ahead of April's forecast of 20%) and almost back up to the December-quarter's US$79.9m. This was driven by PA module sales up 29% (to 33% of total sales from just 1% a year ago). However, a US$22.1m charge comprised a US$15.3m inventory reserve, asset impairment charges of US$2.8m related to MMIC test handlers (due to the shift in demand from individual MMICs to modules), and US$4m due to outsourcing all production packaging and converting the packaging line to an all-R&D facility.

For the September quarter, RFMD is currently fully booked (leading to about 10% sequential growth) and on track to begin production shipments of new PA modules for both TDMA and GSM/GPRS handsets (with modules expected to rise to about 50% of sales).

RFMD still expects a return to profitability in second-half 2001 and continued year-over-year revenue growth for fiscal 2002 (to end-March).

ANADIGICS Inc (Warren, NJ, USA) has entered production with InGaP HBT PA modules, displacing MMIC business for CDMA. However, the low production volume environment and the ramp of its HBT module assembly process led to a loss of US$14.5m on Q2/2001 sales of US$18.9m (down 33.7% on Q1/2001, more than the earlier forecast of 25%). As well as continued low fab utilization, this was due to higher-than-expected start-up costs from the steep ramp in module production.

ANADIGICS now expects Q3 sales down again to US$15.5m (rather than its previous forecast of sales level with Q2), reflecting a change in production ramp schedules of wireless handset platforms and the timing of new design wins. However, for Q4 it expects an increase, fuelled partly by increased HBT module production.

Now that **Celeritek Inc** (Santa Clara, CA, USA) has proprietary single-supply HBT technology, it has launched its 'TrueTriangle' family of InGaP HBT low-voltage (3V) power amplifiers, packaged in 6mm x 6mm, 50 Ω matched modules which need no further external matching elements.

Yield improvements have led to June-quarter module shipments of over five times March-quarter shipments (to 37% of the total) "as customers continue to transition from power amplifier ICs to modules," said president and CEO Tamer Husseini. Total sales of US$14.0m (down from US$19.7m a year ago) included US$8.1m of semiconductors (down 50% for infrastructure applications but up 59% for handsets). Celeritek expects next-quarter sales again of about US$14m.

For **Alpha Industries Inc** (Woburn, MA, USA) fiscal Q1/2002 sales (to end-July) were US$32.2m (down 51% on a year ago and 40% on the

previous quarter). However, they have "begun to see signs of a recovery," said president and CEO David Aldrich, after securing initial orders for its tri-band InGaP HBT PA modules (for production in early 2002).

Alpha expects handset sales to grow 30% in the September quarter, enough to grow its sales 5-10%. For the December quarter, it expects growth of at least 20%, fuelled by the production ramp of such new products and initial orders for GPRS.

Alpha has also launched front-end modules incorporating SAW filters and LTCC packaging technology and is co-developing a new family of switch/filter modules for GSM handsets (targeting 2nd-tier cell-phone makers such as Sony, Mitsubishi and Samsung) for production later this year.

"Through new products such as the switch/filter module and tri-band InGaP power amplifier, our aim is to integrate the RF functions of the handset," says Aldrich (see Issue 1, p9). "The centrepiece of this strategy is our Alpha Integration Platform". This aims to integrate GaAs MMIC HBT and pHEMTs and RF devices into amplifier and switch/filter modules.

However, growth in new handsets is not as rapid as the decline in mature handsets. R&D investment (focused on module integration and advanced-process development) has therefore grown to 30% of sales.

Alliances for integration of GaAs and SiGe

As well as integrating GaAs RFICs and SAW filters in modules, the demand for integrated RF solutions has led to a trend for chip manufacturers to develop complementary GaAs and SiGe RFIC capabilities through alliances.

For example, TriQuint and **Atmel Corp** (San Jose, CA, USA) are cooperating in a joint development to design, manufacture, and market integrated solutions for CDMA handsets, using the complementary RFIC experience of TriQuint's GaAs and Atmel's SiGe technology. They are currently developing a complete RF chip-set solution for CDMA handsets (see Issue 5, page 16).

Also, expanding on an existing cooperation to bundle power amplifiers with other wireless chips into a complete chip-set for digital handsets, in May RFMD announced a strategic alliance with **Agere Systems Inc** (Allentown, PA, USA) to jointly develop, design and manufacture (from Q4/2001) high-performance RFICs for next-generation, data-capable digital cell phones and other wireless products (covering a US$58m investment by RFMD in Agere's fab in Orlando, FL over the next two years). This will provide silicon capacity to RFMD while giving both the benefits of combined operations and increased manufacturing volumes. RFMD will deploy silicon manufacturing engineers in Orlando. Agere and RFMD will work together on RF chips based primarily on SiGe, but the alliance will also encompass Agere's other silicon processes.

So, as RF module technology becomes standard and integration levels increase (driven by the increased complexity of 2.5G/3G wireless), it can be expected that such alliances between complementary component manufacturers will become more commonplace.

The trend to outsourcing

The effect of the slowdown has been for the outsourcing of cell-phone manufacturing to contract electronic manufacturers and spin-off cell-phone companies through alliances: in late January Ericsson announced that it was outsourcing almost all of its manufacturing to Flextronics (while merging its design operations with the Sony Corp); Philips is shedding manufacturing (transferring its plant to its Chinese joint venture - see Issue 6, page 6); and Alcatel is also shedding manufacturing. So, as cell phones become more of a commodity, major vendors are outsourcing more production and design work to low-cost suppliers.

In fact, after being overtaken by Nokia as market leader in 1999 (and its market share down to about 13% this spring while Nokia soared past 35%), Motorola is to sell its most advanced chip-sets, software and production tools to other handset manufacturers (probably second-tier manufacturers like Philips, Alcatel and several Asian manufacturers). This will cut costs and design time and also giving new entrants a quick start, betting that any increase in competition to its handset business (its largest unit) will be more than offset by new revenue for its chip business from the stimulation to the handset industry.

The technology to be sold will start with integrated chip-sets containing contain roughly half the 200-300 separate components in today's phones in less than two-thirds the space, along with reference materials to make it easy for others to redesign the building blocks or change components.

* Earlier this year, after China announced that it intended to create its own cell-phone manufacturing industry, Motorola signed an agreement to provide the technology for second-generation (voice-only) phones.

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